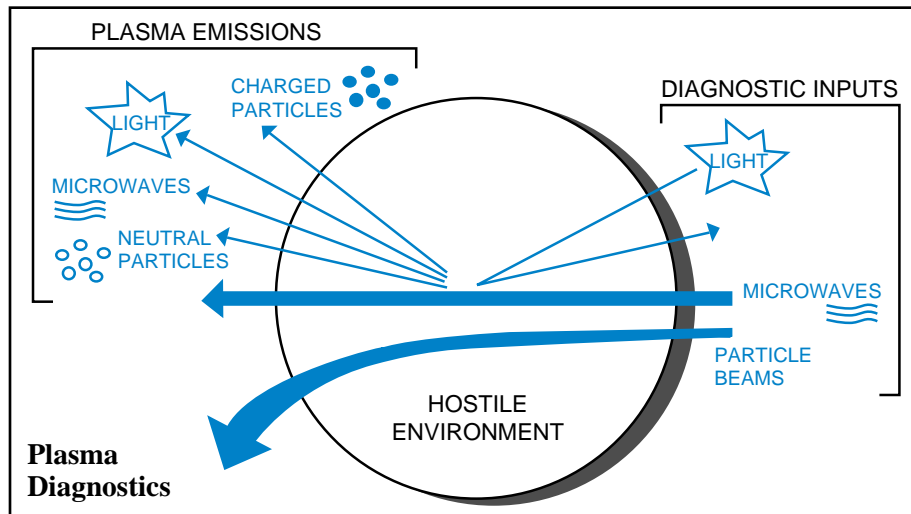


# INSTRUMENTATION AND MEASUREMENT

## DIAGNOSTIC DEVELOPMENT

Understanding the behavior of a fusion plasma has required the development of instruments and techniques for measuring the plasma parameters. The development of these “diagnostics,” which must be able to tolerate the hostile environment created by the high temperatures and energetic particles in the plasma, has led to advances in detector and laser technology, with applications in energy conservation, aerospace, manufacturing, and health and medicine.



A hydrogen plasma glows with a bright reddish-purple color. Looking at this visible light is one way to determine what is happening in a plasma. Fusion researchers also use electromagnetic radiation with wave lengths both longer and shorter than those of visible light to “look” at plasmas.

The light, microwaves, and particles that are emitted by the plasma are measured using cameras, spectrometers, particle analyzers, and other specialized instruments. Fast reciprocating probes, laser beams, particle beams, and microwaves are used to make active measurements.

Techniques developed to monitor the position of the plasma in a fusion device have been incorporated into boiler imaging pyrometers that continuously measure the flame temperature in fossil-fuel power plants. Plant operators save energy by precisely controlling the oxygen and fuel mix

for optimum efficiency. This system was developed by Princeton Plasma Physics Laboratory (PPPL) for Public Service Electric and Gas Corporation.

Lasers are valuable in measuring a variety of plasma parameters, and a new type of laser with medical and manufacturing applications has been developed as the direct result of fusion research.

In 1976, as the result of work on a fusion experiment called the Floating Multipole, it was theorized that a plasma could serve as a medium for soft X-ray lasing action. (Here “soft” refers to the ability of the X rays to penetrate the medium through which they pass.) In 1984, PPPL scientists successfully demonstrated X-ray lasing at a wavelength of 18.2 nanometers (nm).

The soft X-ray laser (SXL) is now being applied to microscopy.

